5 Monitoring Programs

Monitoring the health of the watershed is at the core of the Bureau of Watershed Management's efforts to provide a clean water supply. Water quality sampling and field inspections help ensure compliance with state and federal water quality criteria for public drinking water supply sources. The Bureau also samples to better understand the responses of the reservoir and its tributaries to a variety of physical, chemical, and biological inputs, and to assess the ecological health of the reservoir and the watershed.

BWM staff utilize state-of-the art techniques to test the water in the reservoir and its tributaries. Development impacts are closely monitored and mitigated through the Watershed Protection Act; the Bureau also relies on other state, local and federal laws to minimize the impacts of human activity. Environmental Quality Assessments (EQAs) are performed on sub-watersheds in a five-year cycle in order to identify potential water quality problems, seek out the source of the problem, and identify options for remediation.

5.1 Water Quality Monitoring

5.1.1 Watershed

Accomplishments:

- Continued routine tributary monitoring from over 50 sampling stations on 38 tributaries in the Wachusett Reservoir watershed.
- Continued supplementing routine water quality sampling program with biomonitoring to obtain a better understanding of fluctuations in water quality.
- Completed a report on the Wachusett tributaries that analyzes ten years of physical, chemical, and biological data, presents statistics, evaluates apparent trends, and ranks twenty-four streams with multiple years of available data using a variety of criteria.
- Continued to collect non-routine samples to document and support enforcement actions for events such as failed septic systems, illegal discharges, hazardous materials spills, and runoff from construction sites. Special samples were also collected to investigate, document, or remediate specific water quality issues throughout the watershed, including a study identifying sources of fecal coliform bacteria in the watershed, a long-term study on the impact of sewering a small urbanized subbasin, and studies on stormwater quality from different land uses.
- Continued use of stream gages to measure stream flow, including two continuous flow gages on the Quinapoxet and Stillwater Rivers.

Assessment:

Water quality sampling and watershed monitoring make up an important part of the overall mission of the Bureau. Water quality sampling and field inspections help identify tributaries with water quality problems, aid in the implementation of the Bureau's watershed protection plan, and ensure compliance with state and federal water quality criteria for public drinking water supply sources. Bacterial monitoring of tributaries provides an indication of sanitary quality and helps to protect public health. The Bureau also samples to better understand the responses of the tributaries to a variety of physical, chemical, and biological inputs, and to assess the ecological health of the watershed.

Key Actions:

- Continue routine and non-routine water quality sampling and biological monitoring in the watershed.
- Complete a five-year update to the report by BWM focusing on ten years of fecal coliform bacteria and conductivity data on the Wachusett tributaries, which will further refine BWM's ability to establish priorities among watershed programs and subbasins.
- Continue use of stream gages to measure stream flow.
- Continue to work with UMASS to refine use of alternative source-specific indicators to help discriminate sources of microbial contamination
- Focus efforts on stormwater sampling to improve understanding of primary external source of reservoir contamination.

Background

Over the past fifteen years, water quality samples have been collected from 58 stations on 38 tributaries in the Wachusett Reservoir watershed (only a subset of stations, however, were sampled each year). Parameters measured included total and fecal coliform bacteria, conductivity, temperature, dissolved oxygen, pH, alkalinity, turbidity, selected nutrients and metals, hardness, color, and chlorides.

Current Program and Accomplishments

Water Quality

Water quality samples were collected from 46 stations on 35 tributaries in 1999 and 2000 (**see Figure 5-1**). Samples have been collected from 20 stations on 15 tributaries for the past three years to facilitate analysis of total coliform and an increase in the frequency of sampling to capture storm event and post-event water quality.

Each tributary station was visited weekly throughout the year, with additional samples collected, when possible, during or following storm events. Temperature and conductivity were measured in the field using a Corning CD-30 conductivity meter and samples were collected for coliform analysis. All analyses were done at the BWM lab facility in John Augustus Hall in West Boylston. Samples for nitrate-nitrogen, nitrite-nitrogen, ammonia, silica, total phosphorus, UV-254, total suspended solids, and total organic carbon were collected monthly or quarterly from stations with available flow data (depth measurements were done to calculate flow using previously established USGS rating curves) and analyzed at the MWRA Deer Island Lab. Monthly samples for metals were collected from the Quinapoxet and Stillwater Rivers during 2002 and 2003 and sent to the MWRA as well.

Macroinvertebrates were collected during the spring from 13 stations on 11 tributaries in 1998 and from 23 stations on 20 tributaries in 2001. Additional samples were collected during the summer and fall of 2001 to investigate seasonal variations in Wachusett tributaries. Samples from 1998 have been identified and stream quality assessed by comparing results with historic data compiled over the past sixteen years.

Water quality data have been collected annually and a yearly summary published each spring by BWM since 1988. A ten-year report (1988-1997) was published in 1998 and is the first

Figure 5-1: Wachusett Reservoir Watershed Sampling Stations and RUSS Buoys Locations
Go to: www.mass.gov/dcr/waterSupply/watershed/documents/2003WachWPPfig5_1.pdf

comprehensive effort to summarize all data collected for Wachusett Reservoir watershed tributaries and to interpret long-term trends and rank tributaries based on water quality. BWM has been able to utilize this information to help locate sources of contamination and to prioritize investigations and remedial actions. Data gaps were identified and the knowledge used to focus sampling efforts and parameter choices.

BWM began a cooperative research relationship with the University of Massachusetts Department of Civil and Environmental Engineering in 1996 to investigate and develop methods to differentiate microorganisms found in watershed surface waters. The project aims to improve understanding of fecal coliform bacteria contamination in the watershed by testing various analytical methods and parameters to differentiate between contamination from humans and contamination from animals. Locating the source of fecal coliform bacteria is simplified if it is possible to first determine if the bacteria are from humans or animals. A comprehensive literature review was conducted to gather information on potential testing methods. Several methods were screened, and three tests were selected as having potential to identify the following microorganisms in the watershed system:

- *Bifidobacteria* - a bacterium which is a specific indicator of human fecal contamination.
- *Rhodococcus coprophilus* - a bacterium found in animals.
- *F specific RNA coliphage* - a bacteriophage which can identify human fecal contamination.

Working with BWM staff, UMASS researchers continue to develop and refine these tests to evaluate their ability to determine actual sources of fecal contamination, and for use by BWM staff in the water quality laboratory. A number of preliminary conclusions have been drawn:

- No strong correlations and linear relationships exist among established indicators and proposed alternative indicators.
- Source specific indicators cannot replace coliform to indicate pathogen risk.
- Source specific indicators are more applicable in highly developed settings than in less developed areas.
- Traditional coliform monitoring should continue in conjunction with measurements of source specific organisms. This will help with long-term watershed management and source water protection planning, and should help discriminate sources of microbial contamination.

BWM continues to collect data to document the positive impacts of sewering in the watershed. Several years of baseline nutrient and bacteria levels have been collected in a small urbanized subbasin with numerous failing septic systems. More than a decade of routine water quality data from other subbasins with septic system problems also exists. Sewers are now in the ground in several of these subbasins and a significant number of homes connected, and both routine and stormwater samples were collected during 2003 to help illustrate water quality improvements.

Water quality data from the first six months of 2003 were compared with results from the similar period in 2002 and 2001 to see if any improvements could be seen. Most tributaries in the watershed had water quality in 2003 that was very similar to what had been measured during the previous two years. Median fecal coliform bacteria concentrations were nearly identical in many streams, as was the percentage of samples exceeding the state standard of 20 colonies per 100mL. Both metrics were sharply improved in five stations in Gates Brook, a highly contaminated urban tributary historically impacted by inadequate septic systems. Preliminary results suggest that the new sewer in this area has had a significant positive impact.

BWM is conducting a special monitoring program to characterize stormwater quality from three different land uses. UMASS has been able to focus on stormwater quality and different land uses in cooperation with BWM as part of a study, funded by the American Water Works Association Research Foundation, of three small subbasins in the Wachusett and Quabbin Reservoir watersheds. Data are being collected and a preliminary report on findings has been released. Source-specific indicators appear able to differentiate threats from different land uses, although there are various limitations associated with each indicator. Additional work is planned for 2004.

Flow

BWM staff estimate tributary flow when collecting water quality samples at the monitoring stations using established stage/discharge curves. The continuous stream gages are maintained through a contract with the USGS, and the resulting data are reported in the USGS annual reports. The work consists of monitoring, quality assurance/quality control, and publishing the data for fourteen stream gauges and two groundwater wells throughout the Wachusett Reservoir, Ware River, Quabbin Reservoir, and Sudbury Reservoir watersheds. The Stillwater and Quinapoxet River data are also real-time data retrieval stations and are accessible on the Internet. These allow the Bureau to associate sampling information with actual rainfall occurrence to establish relationships between pollutant loading and precipitation. Many of the other stream gauge data are used to monitor for compliance with minimum releases.

Table 5-1
Wachusett Reservoir Watershed Stream Gauges

NUMBER	DESCRIPTION	DATA PROVIDED
Stream Gauges		
01095220	Stillwater River, Sterling	Real-time data-Precip, Flow, Temp., Cond.
01095375	Quinapoxet River - Canada Mills, Holden	Real-time data-Precip, Flow, Temp., Cond.
01173000	Ware River, Intake Works, in Barre	Statutory Release Monitoring Requirement
01175500	Swift River, At West Ware	Statutory Release Monitoring Requirement
01170500	Connecticut River, Montague City	Statutory Release Monitoring Requirement
01098530	Sudbury River, Saxonville	Statutory Release Monitoring Requirement
01174500	East Branch Swift River near Hardwick	Supply Flow Monitoring, Pollutant Loading
01174565	West Branch Swift River near Shutesbury	Supply Flow Monitoring, Pollutant Loading
Other Stream Staff Gauges		
01095446	French Brook	Supply Flow Monitoring, Pollutant Loading
01095442	Malagasco Brook	Supply Flow Monitoring, Pollutant Loading
01095438	Muddy Brook	Supply Flow Monitoring, Pollutant Loading
10195434	Gates Brook	Supply Flow Monitoring, Pollutant Loading
01095420	W. Boylston Brook	Supply Flow Monitoring, Pollutant Loading
01095410	Malden Brook	Supply Flow Monitoring, Pollutant Loading
Groundwater Wells		
SYW 177	Rte 140 across from #160, Sterling	Monitor Local Conditions
WSW 26	Prescott St. South of Pleasant, W. Boylston	Monitor Local Conditions

Source: DCR/DWSP/BWM Wachusett Section EQ, 2003

USGS also evaluates and monitors staff gauges at six tributaries to the Wachusett Reservoir to update the rating curves every other year. These gauges are used to determine the flow in the tributary and to assess water volumes and pollutant loads entering the Wachusett Reservoir.

The USGS compiles and publishes data that historically was collected by the Bureau from eight groundwater wells. Due to budgetary cutbacks, monitoring was reduced to two sites in 2003. Groundwater levels are used to establish actual referenced groundwater elevations to aid the Bureau. Local conservation commissions and boards of health use the information to assess groundwater levels in a range of different soil types. These data helps these local boards to, respectively, define and apply corrections to groundwater levels determined for application of standards contained in the DEP Stormwater Policy and achieve compliance with Title 5.

Staff gauges for West Boylston Brook and French Brook are in disrepair due to activities of wildlife in the area and have not provided acceptable data since 2001. The Bureau and USGS identified improved locations and completed installation in the fall of 2003.

Assessment

Water quality in the tributaries over the past five years has remained relatively unchanged, although some significant improvements were recently detected in Gates Brook following the completion of a municipal sewerage system in the area. Most tributaries had annual median fecal coliform bacteria concentrations similar to those recorded over the previous ten years. A few showed minor water quality improvements; none exhibited a decline in water quality.

Further refinement of specific methods will enable the utilization of alternative indicators such as *E. coli*, *enteroccocus*, Bifidobacteria, *Rhodococcus coprophilus*, and *F specific RNA coliphag*e to better understand water quality and to prepare for changing EPA standards. The Bureau will also continue with routine monitoring, stormwater sampling, and macroinvertebrate collection to provide a complete understanding of watershed water quality

Control Approach

Goals

- To perform water quality sampling in order to help ensure compliance with state and federal water quality criteria for public drinking water supply sources.
- To better understand the responses of the tributaries to a variety of physical, chemical, and biological inputs, and to assess the ecological health of the watershed.

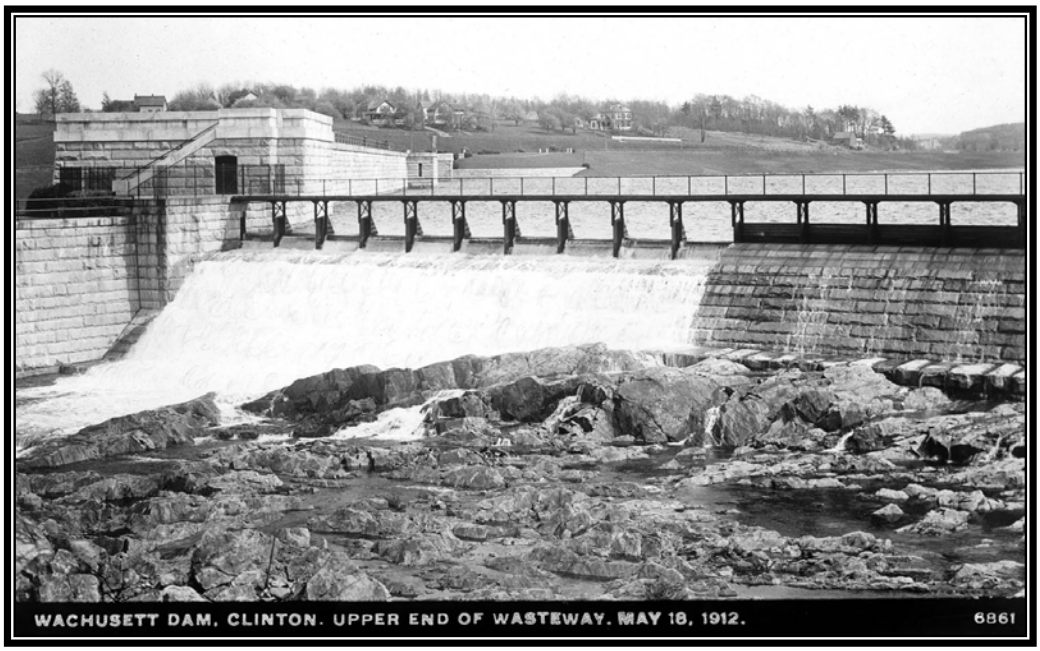
Objectives

- Sample tributaries with an emphasis on both dry and wet weather sampling, further documenting water quality under varying conditions.
- Closely examine updated water quality information in order to document changes and help focus additional remediation efforts.

- Use alternative indicators, biomonitoring, and special studies to improve the Bureau's understanding of current and future conditions in the watershed.

Action Items

- Continue routine and non-routine water quality sampling and biological monitoring in the watershed.
- Complete a five-year update to the report by BWM focusing on ten years of fecal coliform bacteria and conductivity data on the Wachusett tributaries, which will further refine BWM's ability in establishing priorities among watershed programs and subbasins.
- Continue use of stream gages to measure stream flow.
- Continue to work with UMass to refine use of alternative source-specific indicators to help discriminate among sources of microbial contamination
- Focus efforts on stormwater sampling to improve understanding of primary external sources of reservoir contamination.



5.1.2 Reservoir

Accomplishments:

- Continued routine reservoir monitoring at three reservoir locations. Installed two continuous, real-time Remote Underwater Sampling Stations (RUSS), providing significant additional water quality information.
- Monitored plankton populations in the Wachusett Reservoir in order to detect increasing concentrations (blooms), potential taste and odor problems, and to recommend, when necessary, copper sulfate treatment. Initiated sampling at Quabbin Reservoir to help further understand plankton population dynamics in the multi-reservoir system.
- Published two comprehensive summary reports describing plankton populations and nutrient dynamics in the Quabbin and Wachusett Reservoirs.
- Implemented a pilot treatment plan for plankton control developed by CDM for MWRA in 2001.
- Significantly lowered the detection limits for nutrients.
- Initiated Macrophyte (rooted aquatic plant) surveys in 1999 in order to detect alien species and characterize the reservoir macrophyte community. A colony of the invasive alien species Eurasian Water-milfoil was detected in the upper reaches of the reservoir in 2001; control efforts were immediately implemented and a long-range program initiated.
- Developed a two-dimensional water quality model of Wachusett Reservoir, which is being refined and calibrated under contract with the University of Massachusetts.
- A thorough understanding of the "Quabbin interflow" and its impact on reservoir water quality has led to better management of reservoir transfers in response to water treatment issues.
- Coordinated the Reservoir Operations Group, a forum for BWM and MWRA to exchange ideas and research results, and to update or modify operating policies for the Quabbin and Wachusett Reservoirs.

Assessment:

Water quality sampling is an important part of the overall mission of the Bureau, helping to identify water quality problems, aid in the implementation of the Bureau's watershed protection plan, and ensure compliance with state and federal water quality criteria for public drinking water supply sources. Bacterial monitoring of the reservoir provides an indication of sanitary quality and helps to protect public health. The Bureau also samples to better understand the responses of the reservoir to a variety of physical, chemical, and biological inputs, and to assess the ecological health of the reservoir and the watershed.

Key Actions:

- Continue routine and non-routine water quality sampling (including plankton monitoring) in both reservoirs.
- Continue macrophyte control efforts to stop the spread of Eurasian Water-milfoil in the reservoir and to reduce the source population in the Stillwater Basin.
- Complete and utilize water quality model to assist with reservoir operations decisions.
- Continue to coordinate the Reservoir Operations Group.

Background

Over the past seventeen years, water samples have been collected from a number of stations on the Wachusett Reservoir. Parameters measured included total and fecal coliform bacteria,

phytoplankton, nutrients, conductivity, temperature, dissolved oxygen, pH, alkalinity, turbidity, and chlorides, although not all parameters were measured each year.

Historical measurements of nutrients in Wachusett Reservoir are documented in reports from two sampling programs conducted by private firms under contract with the Bureau. The consulting firm of Tighe & Bond conducted sampling and nutrient analysis of Wachusett Reservoir (and other BWM resource waters) from May 1986 through May 1988. A shortcoming of this study is that sampling was limited to surface grabs, which precluded the detection of vertical variations in the concentrations of certain nutrients, a major feature of the recently generated database.

Six years later the consulting firm of Camp, Dresser, & McKee (CDM) conducted sampling and nutrient analysis of Wachusett Reservoir from April 1994 through December 1994. Sampling at various depths in the water column was a component of this study and CDM results showed seasonal and vertical patterns consistent with more recent findings.

Both studies entailed field measurements and water sampling at a variety of locations across the basin. Many of the stations used for contemporary monitoring efforts are those originally established in these historical studies.

The main source of historical phytoplankton data is the program of weekly sampling since 1987 conducted off the catwalk at the rear of Cosgrove Intake. These samples have been supplemented for several years with additional sample locations that increased spatial coverage of the reservoir basin. All data have been recently reviewed and summarized as described below.

Current Program and Accomplishments

Water Quality

BWM collects monthly temperature, dissolved oxygen, pH, and conductivity profiles at three reservoir stations using a Hydrolab Surveyor III. Quarterly samples for nitrate-nitrogen, ammonia-nitrogen, total Kjeldahl nitrogen, silica, alkalinity, and total phosphorus are collected at the same three stations and the Cosgrove Intake from three depths during thermal stratification and at two depths during isothermal conditions. All parameters are analyzed by the MWRA Lab at Deer Island using low detection limits.

Coliform samples are collected five times per week at the Cosgrove Intake to ensure compliance with federal regulations and to help monitor the effect of weather conditions, tributary inputs, and migratory gull and geese populations on bacteria concentrations. Coliform samples are also collected monthly, biweekly, or weekly at numerous locations on the reservoir surface, documenting the relationship between seasonal bacteria variations and roosting populations of gulls and geese on the reservoir as well as the impact of harassment on both birds and bacteria concentrations. A sampling grid with twenty-three sampling locations based on reservoir configuration and flow paths was utilized, and an additional sampling location near the dam was added in anticipation of withdrawals through the Wachusett Aqueduct in 2003.

Giardia and *Cryptosporidium* sampling is an important part of water quality monitoring, following the increased concern for these disease-causing agents throughout the drinking water industry. DWM began collecting pathogen samples in 1994. Routine sampling was discontinued in 2001 after the compilation of seven years of baseline data. No seasonal trends were identified; presence or absence appear to be related to precipitation and flow. The MWRA continues to collect weekly samples at the Cosgrove Intake, and samples are also collected from a tributary as part of the UMASS stormwater study.

Plankton samples are collected weekly or biweekly at the Cosgrove Intake and quarterly at three additional stations throughout the year when ice cover is not present. Sampling at the Quabbin Reservoir was done monthly for a year and continues on a quarterly basis at several stations. All data are transmitted weekly to the MWRA to enable time-sensitive decisions on potential copper sulfate applications. Two comprehensive summary reports describing plankton populations and nutrient dynamics in the Quabbin and Wachusett Reservoirs were published.

Nutrient and Plankton Dynamics in Quabbin Reservoir (MDC, 2002e) details the scope, methods, and results of an intensive program of monthly sampling and analysis of nutrients and plankton from October 1998 through September 1999. The frequency of sampling, spatial coverage (multiple depths at six stations) and improved analytical capability of the MWRA Deer Island laboratory provided the most comprehensive database available for Quabbin Reservoir. Major findings include marked seasonal and vertical variations in nutrient concentrations due to plankton dynamics, a slight horizontal gradient in silica concentrations correlated to hydraulic residence time, and an annual cycle of phytoplankton succession and abundance characteristic of many temperate, oligotrophic systems. These findings also helped develop a better understanding of similar processes in Wachusett Reservoir.

Beginning in October of 1998, Bureau staff initiated a year-long program of monthly sampling of Wachusett Reservoir at multiple stations and depths. The goal of this program was to document current nutrient and plankton dynamics and to update the existing database on nutrient concentrations and plankton characteristics. At the conclusion of monthly sampling in September 1999, a modified program of nutrient monitoring was continued on a quarterly schedule.

Nutrient and Plankton Dynamics in Wachusett Reservoir (MDC, 2003a) details the scope and methods of both the monthly and quarterly components of the monitoring program and presents an analysis of the results through December 2002. Also presented is a review of plankton data generated from BWM sampling conducted at Cosgrove Intake on a weekly basis (ice conditions permitting) since 1987 and supplemental reservoir sampling conducted in 1988, 1989, 1995, and 1996. The report integrates historical nutrient and plankton data generated from studies of Wachusett Reservoir contracted by the MDC/DWM and completed prior to 1998.

A pilot treatment plan for plankton control was developed by CDM for MWRA in 2001. The study proposed dispersion of copper sulfate using air-lift mid-depth circulators to treat nuisance plankton during difficult weather or ice-covered conditions, or when problem species are located well below the surface and control using a surface application would be ineffective.

The pilot treatment plan was tested during the summer and fall of 2001 using a single circulator and Rhodamine WT dye to simulate dispersion of liquid copper sulfate. The circulator was placed

between 15 and 25 meters deep during the summer and between 5 and 15 meters deep during the fall. The circulator was anchored to the bottom of the reservoir and attached to a floating barge outfitted with a propane-fueled air compressor. Several dye treatments were attempted and the results published by CDM in 2002. Although the piloting was viewed as generally successful, full scale implementation was not proposed at that time due to budget priorities and the success to date of traditional surface application.

Samples collected by BWM and MWRA are analyzed at the MWRA laboratory on Deer Island. There is a need for BWM to be able to analyze nitrogen and phosphorus at very low levels, and MWRA laboratory staff currently use low-level detection methods that are not readily available through commercial laboratories. Since BWM no longer needs to award contracts to commercial laboratories through a bidding process, the relationship with the MWRA laboratory enables BWM to avoid possible data gaps or comparability issues among different commercial labs. All nutrient data from July 1998 to present was done using low-level methods.

A two-dimensional water quality model of Wachusett Reservoir has been developed, and is being refined and calibrated under contract with the University of Massachusetts. Details of this project are found in Section 8.4.

Flow

The transfer of water from Quabbin to Wachusett Reservoir via the Quabbin Aqueduct has a profound influence on the water budget, profile characteristics, hydrodynamics, and water quality of the Wachusett Reservoir. During the years 1995 through 2002, the amount of water transferred annually from Quabbin to Wachusett ranged from a volume equivalent to 44 percent of the Wachusett basin up to 94 percent. The period of peak transfer rates generally occurs from June through November. However, at any time of the year, approximately half of the water in the Wachusett basin is derived from Quabbin Reservoir.

The peak transfer period overlaps the period of thermal stratification in Wachusett and Quabbin Reservoirs. Water entering the Quabbin Aqueduct at Shaft 12 is withdrawn from depths of 13 to 23 meters in Quabbin Reservoir. These depths are within the hypolimnion of Quabbin Reservoir where water temperatures range from 9 to 13 degrees C in the period June through October. This deep withdrawal from Quabbin is colder and more dense relative to epilimnetic waters in Wachusett Reservoir. However, due to a slight gain in heat from mixing as it passes through Quinapoxet Basin and Thomas Basin, the transfer water is not as cold and dense as the hypolimnion of Wachusett. Therefore, Quabbin water transferred during the period of thermal stratification flows conformably into the metalimnion of Wachusett where water temperatures and densities coincide.

The term interflow describes this metalimnetic flow path for the Quabbin transfer that generally forms between depths of 7 to 15 meters in the Wachusett water column. The interflow penetrates through the main basin of Wachusett Reservoir (from the Route 12 Bridge to Cosgrove Intake) in about 3 to 6 weeks depending on the timing and intensity of transfer from Quabbin. The interflow essentially connects Quabbin inflow to Cosgrove Intake in a “short circuit” undergoing minimal mixing with ambient Wachusett Reservoir water.

Two in situ monitoring buoys known as Remote Underwater Sampling Stations (RUSS) were first deployed for seasonal data collection at Wachusett Reservoir in late April 2002. One is located in the main body of the reservoir just outside of Thomas Basin at the southwestern end and the other is located just off Cosgrove Intake at the northeastern end. These two locations represent essentially the two extreme ends of the main body of the reservoir and permit the monitoring of water quality as the principle inflows from the Quinapoxet River, Stillwater River, and the Quabbin Reservoir transfer (interflow) pass from Thomas Basin northeast to the Intake (**see Figure 5-1**). The buoys allow several depth profiles to be collected each day without the deployment of staff in boats.

Both buoys are fitted with Hydrolab data collection instruments. Data are collected four times each day at the Cosgrove Intake area buoy. Each run has 23 depth readings for pH, temperature, turbidity, and conductivity, which are communicated via cellular phone to a land-based computer. Data are collected two times each day at the Thomas Basin buoy and each run has 16 depth readings. Data collected since the buoys have been in place have resulted in some preliminary findings, which will aid in reservoir management decision-making. These include the following:

1. An analysis of Quabbin Reservoir interflow arrival time at Cosgrove Intake was performed by using daily samples from the buoys. For example, in late 2002, using conductivity measurements to track Quabbin water, it was observed that the Thomas Basin buoy conductivity dropped off rapidly and then leveled out after 50 days. Comparing this with existing data from 1998 through 2002, and the start of Quabbin water arrival time at Cosgrove Intake, it was found that the arrival time depends in part on when the transfer is started, and generally, the more water that is transferred the faster it moves. It was also found that a significant factor in travel time is the strength of the stratification level of the reservoir.

2. In comparing recorded wind data at the time of buoy sampling, it has been observed that a wind threshold of about 10 mph appears to change the reservoir water temperature/conductivity relationships as water is driven down and mixes.

3. Reservoir turnover can be assessed as it is occurring.

These factors help determine optimum transfer periods for Quabbin water. The buoys also have provided information on rates of change of physical conditions and water quality parameters, and provide the ability to develop baseline data for future research. This may prove beneficial to ongoing modeling efforts underway in conjunction with the University of Massachusetts (Amherst) Department of Civil and Environmental Engineering.

A thorough description of the "Quabbin interflow" and its impact on reservoir water quality can be found in a recent summary of nutrient and plankton dynamics in Wachusett Reservoir (MDC, 2003a). In addition to positive impacts on nutrient and plankton concentrations, the lower organic content in water transferred from Quabbin results in lower disinfection byproduct formation at the Cosgrove Intake. Understanding the interflow and how it impacts water quality has led to better management of reservoir transfers in response to water treatment issues.

Macrophytes

Routine macrophyte (rooted aquatic plant) surveys of Wachusett Reservoir were initiated by MDC staff in 1999. Surveys consist of visual observations and mapping of littoral zone vegetation from a boat. Each survey effort generally focuses on a discrete shoreline area and is often performed in conjunction with other field activities involving boat operation. Observations of macrophytes growing at depth are aided by the use of a view box. Specimens are collected with a rake or grab when needed to facilitate plant identification.

The macrophyte flora of Wachusett Reservoir is composed of approximately twenty species including three species non-native to Massachusetts. In August of 2001, a pioneering colony of Eurasian Water-milfoil (*Myriophyllum spicatum*; referred to subsequently as "milfoil") was observed for the first time in Upper Thomas Basin, a small basin in the upper reaches of the reservoir system. A milfoil control program was implemented for the 2002 growing season with funding provided by MWRA and technical assistance from BWM. The consulting firm Aquatic Control Technology, Inc. of Sutton, Massachusetts was selected to conduct a variety of control techniques aimed at eliminating the infestation in Upper Thomas Basin, preventing the establishment of new plants, and restricting the dispersal of autofragments* downgradient to other portions of the reservoir system. The primary control methods used were benthic barriers and hand-harvesting. Benthic barriers are sheets of material installed over bottom substrates to smother existing plant infestations and to prevent colonization of the substrate. Hand-harvesting consists of SCUBA divers physically uprooting specimens of milfoil and removing the plants by hand. The program is continuing during the summer of 2003. Alternative control measures for the heavily infested area upstream of the reservoir were discussed, and a contract for biological control using native aquatic weevils was initiated in the 2003 growing season.

Reservoir Operations

In mid-1998, MWRA and MDC/DWM began to more formally coordinate reservoir operations by holding periodic Reservoir Operations Group meetings. These gatherings have evolved into quarterly meetings and include a range of staff charged with physical, chemical and biological assessments, water elevation maintenance and inter-reservoir transfers, security and emergency response, and special projects.

The group is comprised of MWRA staff and managers from Western Operations, Field Operations, Planning, and Laboratory Services. BWM staff and managers include superintendents of Wachusett Reservoir and Quabbin Reservoir, Environmental Quality, and laboratory personnel. The Water Supply Citizens Advisory Committee (WSCAC) often attends and actively participates in these meetings.

Discussions are routinely held on plankton control, gull harassment, water quality (including monitoring buoys), Ware River diversions, and general reservoir operations, each of which has unique seasonal variations requiring significant coordination. Other timely topics that continue to be prominent include Eurasian milfoil control, construction coordination for MWRA's Integrated Water

* Milfoil autofragments are stem segments with adventitious roots at the nodes that float upon abscission and are the plant's most important mode of reproduction and dispersal. Autofragments of *M. spicatum* eventually sink to the bottom and are capable of colonizing littoral zone areas having only minimal deposits of organic sediment.

Supply Improvement projects (**see Section 7.2**), security issues and pre-positioned deployment of spill-containment equipment, and reservoir transfer protocols.

The Reservoir Operations Group is a forum not only for management of water resources and system operations, but also for coordination and information transfer from research efforts to operational decision-making. Agendas are set and minutes kept of all deliberations.

The Bureau has reinstituted routine monitoring of the snow pack (depth and water content) to help predict spring runoff and aid in reservoir operations decisions.

Assessment

Nutrient and plankton dynamics, and the "Quabbin interflow" and its impact on reservoir water quality, have been described in detail in Sections 2.3, 2.4, and 5.1.2. Water quality in Wachusett Reservoir remains very high, with only minor taste and odor episodes due to plankton and no exceedences of federal or state drinking water standards for fecal coliform bacteria since March of 1999.

Control Approach

Goals

- To perform water quality sampling in order to help ensure compliance with state and federal water quality criteria for public drinking water supply sources.
- To better understand the responses of the reservoir to a variety of physical, chemical, and biological inputs, and to assess the ecological health of the watershed.

Objectives

- Sample the reservoir on a daily, weekly, monthly, and quarterly basis to further document water quality under varying conditions.
- Continue ongoing efforts to keep invasive macrophytes out of the reservoir and to reduce source populations.
- Cooperate with UMASS and the MWRA to further develop and implement reservoir models and utilize information gathered to make sensible reservoir operations decisions that improve or maintain water quality.

Action Items

- Continue routine and non-routine water quality sampling (including plankton monitoring) in Wachusett Reservoir.
- Continue macrophyte control efforts to stop the spread of Eurasian Water-milfoil in the reservoir and to reduce the source population in the Stillwater Basin.
- Complete and utilize water quality model to assist with reservoir operations decisions.
- Continue to coordinate the Reservoir Operations Group.

5.2 Project Monitoring

5.2.1 Watershed Protection Act

Accomplishments:
- Continued ongoing administration of the Watershed Protection Act (WsPA). Over 500 applications were reviewed during the past five years.
- Updated all forms, Guidance Document and the Watershed Protection Act brochure. Created a new brochure entitled "Landscaping and the Watershed Protection Act." All material was posted on the Bureau's website.
- Continued meetings of the Watershed Protection Act Working Group (WsPAWG) on a regular basis.
- Continued formal and informal contact with local Boards regarding the Watershed Protection Act.

Assessment:
Watershed Protection Act review has resulted in more sensitive land development. Some projects have been relocated further away from resource areas. Other construction resulted in less dense development of the land or implementation of additional mitigation measures. Staff continue to review development projects outside of priority resource areas, promoting watershed-wide resource protection.

Key Actions:
- Continue ongoing administration of the Watershed Protection Act.
- Revise ownership information resulting in an updated database.
- Continue to meet with the Watershed Protection Act Working Group.
- Work with towns, general public and other agencies to review projects in the watershed.

Background

The Watershed Protection Act (WsPA) is a law passed in 1992 by the Commonwealth (St. 1992, c. 36). This legislation – also known as the "Cohen Bill" after its initial sponsor, former State Representative David Cohen of Newton – directed the Metropolitan District Commission, Division of Watershed Management (MDC/DWM) to adopt regulations, 350 CMR 11.00, to help protect the sources of water to the reservoirs that provide drinking water to 2.2 million people. The WsPA establishes a "comprehensive scheme to regulate land use and activities within certain critical areas" of the Quabbin Reservoir, Wachusett Reservoir and Ware River watersheds (**see Figure 5-2**).

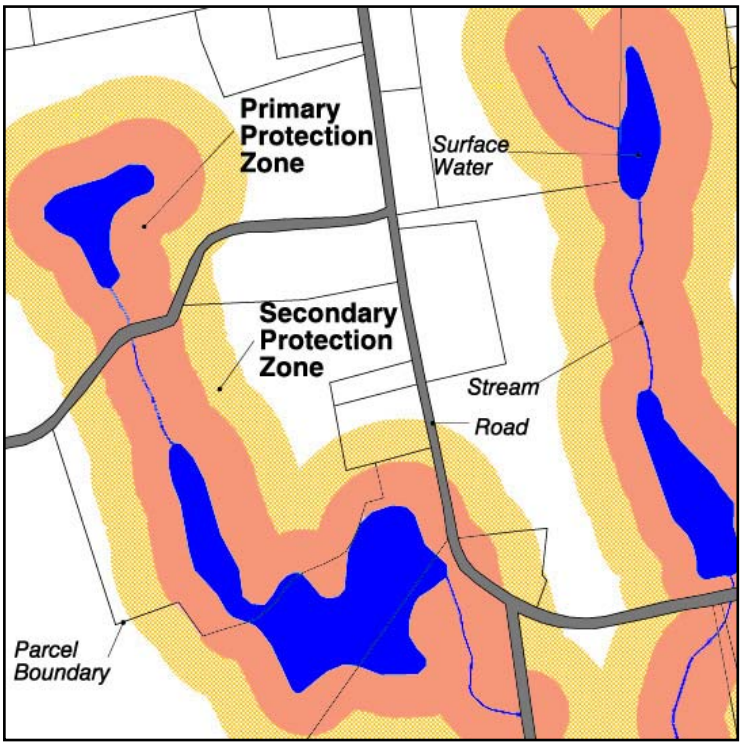
Many aspects of the use and development of land affect the quality of nearby streams which then flow into reservoirs and other sources of water supply. Type of development, density, amount of paved surface, and proximity to river banks are contributing factors to the amount and types of pollutants that can end up in a stream. Some of the strategies used by the WsPA to minimize the effects of human activities on water quality include: preserving a buffer zone along the water resources, limiting impervious surfaces, and restricting the storage and use of hazardous materials.

Through the Act and its regulations, the BWM seeks to avoid detrimental land uses close to water resources and guide development into more appropriate locations, densities and configurations. Two different areas are protected under the WsPA (**see Figure 5-3**; for a complete description, see 350 CMR 11.04).

Figure 5-2: Watershed Protection Act Protection Regulatory Zones and Application Sites in the Wachusett Reservoir Watershed

Go to: www.mass.gov/dcr/waterSupply/watershed/documents/2003WachWPPfig5_2.pdf

Figure 5-3: WsPA Protection Zone Illustration



- **Primary Protection Zone:** Within 400 feet of the reservoirs and 200 feet of tributaries and surface waters, any alteration is prohibited. "Alteration" includes a variety of activities, such as draining, dumping, dredging, damming, discharging, excavation, filling or grading. Generation, storage, disposal or discharge of pollutants is also prohibited in the Primary Protection Zone.

- **Secondary Protection Zone:** Between 200 and 400 feet of tributaries, surface waters, and on land within flood plains, over some aquifers, and within bordering vegetated wetlands, certain activities are specifically prohibited. These activities include: storage, disposal or use of toxic, hazardous, and certain other materials; alteration of bordering vegetated wetlands; and dense development.

The WsPA affects close to 5,000 individual parcels in the Wachusett Reservoir watershed (**see Table 5-2**). The Bureau provides a variety of scenarios for individual property owners to determine whether their parcel is affected by the Act, and if so, whether a proposed activity is either allowed or prohibited by the regulations. Property owners affected by the Act in 1992 received written notification of their status when the law took effect. Ownership, however, changes over time; current property owners can check the location of their parcel relative to the WsPA Protection Zones on maps available at town halls and BWM Field Offices.

Table 5-2
Watershed Protection Act Affected Areas

Watershed	Number of Affected Parcels	Acreage Affected by WsPA			
		Primary Protection Zone	Secondary Protection Zone	Total	Percent of Watershed
Wachusett Reservoir	4,903	5,725	6,580	12,305	17.4%
Ware River	2,221	3,548	4,265	7,813	12.7%
Quabbin Reservoir	1,260	3,628	4,008	7,636	8.0%
Total	8,384	12,901	14,853	27,754	12.2%

Source: DCR/DWSP/BWM, 2003

Owners are recommended to make an inquiry to the BWM if there is a proposed change on the site regarding the use, physical structures, new construction, or any other activity modification. The kind of application submitted will depend on the circumstances of the applicant and the proposed project (**see Table 5-3**).

Table 5-3
Watershed Protection Act Applications

Type of Application *[What to Submit]*	**BWM Response** *[Form of Response]*
Advisory Ruling *[Letter from Owner]*	Informal indication of whether property is affected, if activity is prohibited, if exemption applies. *[Letter from BWM]*
Determination of Applicability *[WsPA Form 1]*	Formal, recordable indication of whether property is affected, if activity is prohibited, if exemption applies (may include water quality finding). *[WsPA Form 2]*
Variance *[WsPA Form 3]*	Decision whether physical characteristics allow law to be varied for this project without water quality degradation or harm to public good. *[WsPA Form 4]*
Exemption of a Tributary *[WsPA Form 5]*	Decision whether several factors allow tributary or portion to be exempted without risk of water quality degradation or harm to public good. *[WsPA Form 4]*

Source: DCR/DWSP/BWM Planning, 2003

Current Program and Accomplishments

BWM staff reviewed 564 WsPA application between January 1998 and June 2003. The majority of these applications were for Advisory Rulings or Determinations of Applicability. There were 39 Variances granted during this time period (**see Table 5-4 and Figure 5-4**).

Staff revised all forms and the brochure used in administration of the Watershed Protection Act. These forms include the Request for Watershed Determination of Applicability, Applicability Decision, Application for Variance, and Variance Decision. The Guidance Document, used mainly by those seeking a Variance Decision, was also updated.

Figure 5-4: WsPA Applications January 1998 – July 2003

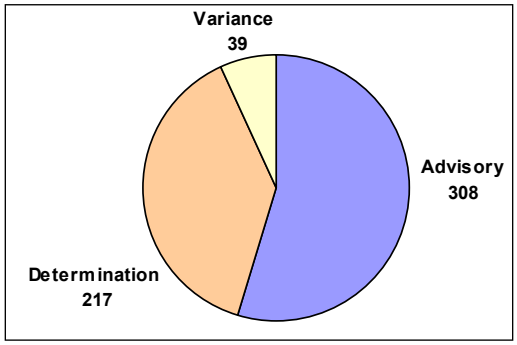


Table 5-4
Summary of WsPA Applications 1998 - 2003

Land Use	# of Applications	% of Total Applications
Residential – Single Family	128	23%
Residential – Multi-Family	9	1%
Residential – Addition	79	14%
Residential – Accessory Use	120	21%
Residential – Septic System	32	6%
Subdivision – minor	9	1%
Subdivision – major	21	4%
Commercial Use	46	8%
Municipal Use	26	5%
Agriculture – existing	2	< 1%
Agriculture – new	1	< 1%
Redevelopment – commercial	16	3%
Redevelopment – municipal	4	< 1%
Right-of-Way – utilities	3	< 1%
Right-of-Way – trains	0	0%
Right-of-Way – roads	18	3%
Other	33	6%
Location Only(No activity)	17	3%
Total	564	100%

Source: DCR/DWSP/BWM Wachusett EQ, 2003

The intent in updating the WsPA forms was to provide as much information to the public as possible, clearly explaining the application, the application process and the decision. In addition, the general WsPA brochure was updated and is now printed in color to better assist and answer questions from the public. A new brochure entitled "Landscaping and the Watershed Protection Act" was developed to help answer questions about how landscaping activities can meet the WsPA regulations.

All of the above information is available to be mailed out to all those who request information on the regulations as well as being posted on the BWM website.

The Watershed Protection Act Working Group (WsPAWG) continues to meet to provide staff from the Quabbin, Wachusett and Boston sections and an MWRA representative the opportunity to consult on general issues, discuss specific cases and apply past precedents. This group also discusses interagency coordination efforts.

Issues that are not necessarily subject to the WsPA but still require BWM attention are referred to other members of the Environmental Quality section. Two examples would be areas of dumping and projects located outside the buffer zones that may potentially impact water quality but would not be regulated under the Watershed Protection Act.

Contact with boards and commission is ongoing and will continue. Staff visit various Town Halls to inquire about proposed projects, discuss current projects, and drop off new maps and brochures. During this time, BWM staff also speak with town staff and answer any questions that may arise about the regulations.

A reorganization of the Wachusett/Sudbury Reservoir Section placed WsPA related duties within the Environmental Quality staff. This realignment creates the opportunity for a more comprehensive approach to reviewing and tracking all development projects within the watershed and the integration of these efforts with the Environmental Quality Assessments (**see Section 5.3**).

Updating the parcel database utilized for WsPA implementation has been an ongoing project for BWM. Several attempts have been made to institute a comprehensive process to update the private landowner's parcel data for the entire Watershed System in the BWM GIS. The different options explored include:

- Towns update the GIS data themselves (ongoing)
- BWM staff update data (1998 – 1999)
- BWM contract with a vendor (2000 – 2001)
- BWM coordinate with MassGIS (2002)

In the Spring of 2001, MDC entered into a contract with Applied Geographics, Inc. to update the coverages for a pilot project to update the data for three towns: Princeton, Hubbardston, and Phillipston. BWM staff are working on integrating these new data into the existing GIS system.

Assessment

The Watershed Protection Act does not stop development, rather it prohibits certain activities while promoting improved site designs in order to better protect water quality. BWM staff work with landowners to ensure that their projects meet the WsPA regulations. This work entails spending a significant amount of time with property owners and/or their representatives (e.g., realtors, lawyers, engineers) to review their proposals, visit the project sites, and provide clear guidance on how different design alternatives will best meet the requirements of the Act. The final plan submitted to BWM after this dialogue is usually much more protective of all the natural resources on the property. For example, residential areas have been developed less densely, individual homes have been sited away from resource areas, and commercial/industrial projects have been revised to include mitigation measures to protect the water supply. Communication and coordination with the watershed towns is also an important element to the Act's successful implementation.

Another key factor in implementing the WsPA is the maintenance of an accurate GIS database. Analysis of the pilot contract with Applied Geographics (see description above for Princeton) concluded that utilization of an outside vendor will not be an effective long-term solution to updating the BWM parcel data. Two key reasons for this conclusion are: 1) the contractor stated that they under-bid the contract and any subsequent work would have significant cost increases (probably into the six-figure range); and 2) attempting to do this kind of work for the BWM rather than for the town itself greatly hinders the access and cooperation required to undertake such a complex task.

The preferred solution to this process is for the towns to digitally maintain their assessor data. This option is coming closer to reality as computers become more powerful and GIS more accessible. The larger towns are starting to use this technology out of necessity. The initiation of a grant program by MassGIS specifically to fund these efforts also helps make this solution possible. Once a critical mass of the towns in the watershed start maintaining digital assessor's data, BWM can concentrate the limited amount of staff time on the remaining areas that could be updated in-house.

Control Approach

Goals

- To prevent impacts to water quality from development in the most critical areas of the BWM water supply watersheds.
- To provide fair and consistent interpretation of the WsPA regulations and timely review and decision making on property applications.
- To utilize the regulations to educate land owners and town officials about the effects of development on water quality and ways to mitigate these impacts.

Objectives

- Implement and enforce all provisions of the WsPA regulations.
- Administer the Act with consistency and fairness.
- Communicate effectively with land owners, town officials, other agencies, and the general public on the WsPA.

Action Items

- Continue to administer individual applications under the Watershed Protection Act regulations.
- Continue to meet with the Watershed Protection Act Working Group.
- Refer development projects not regulated by the WsPA for appropriate review and tracking by Environmental Quality Section staff under other statutory authority.
- Update parcel information in the GIS database.

5.2.2 Watershed Protection and Other Environmental Regulations

Accomplishments:
- Identified and researched possible violations of environmental regulations.
- Developed and implemented draft enforcement protocol with DEP.
- Coordinated with other state agencies in reviewing projects that are subject to various and often multiple, overlapping regulations (e.g., Right-of-Way pesticide/herbicide application, Title 5 on-site wastewater treatment, agricultural sites, private forestry practices, and 21-E state regulated sites).
- Reviewed and commented on proposed changes to state regulations.

Assessment:
There is a broad array of federal, state and local laws and regulations that act as a significant control against potentially polluting activities on private lands throughout the Wachusett Reservoir watershed. While implemented by other entities, BWM staff presence in the watershed can enhance the administration and enforcement of these laws, resulting in a higher rate of compliance. Control of regulated sites and activities through these regulations has minimized the threat these sites pose to water quality.

Key Actions:
- Maintain vigilance locating possible violations of environmental regulations.
- Review enforcement protocol with DEP.
- Continue to coordinate with other state agencies to assist with their regulatory enforcements.
- Continue to review proposed changes to state environmental regulations and local bylaws.

Background

The Commonwealth of Massachusetts and the U.S. Environmental Protection Agency (EPA) have a broad range of laws and regulations collectively aimed at reducing and controlling environmental pollution. **Table 5-5** summarizes key laws and regulations most commonly utilized by BWM staff (including BWM regulations), relevance of the regulations to watershed protection, and the enforcement authority.

During the development of the WsPA regulations (350 CMR 11.01-11.08, **see Section 5.2.1**), the opportunity was taken to streamline all other MDC-related watershed protection regulations into one concise section, 350 CMR 11.09. These rules prohibit any action which could degrade the Waters of the Watershed System (constituting the Wachusett Reservoir, Quabbin Reservoir, Ware River, and Sudbury Reservoir watersheds), or interfere with their use as a source of water supply. Except for specific WsPA related violations, this comprehensive set of regulations is the basis for any enforcement action taken by the Bureau. Coordination with the other local, state and federal environmental statutes provides several avenues to protect water quality.

Table 5-5
Environmental Regulations Employed in Watershed Protection Activities

Regulation	Authority	Issue	Relevance	BWM Role[1]
350 CMR 11.01-08	BWM	Watershed Protection	Provisions of the Watershed Protection Act; establishes protective buffers around resource areas.	Lead administrator. Discussed in Section 5.2.1.
350 CMR 11.09	BWM	Watershed Protection	Prohibits any action which could degrade the Waters of the Watershed System or interfere with their use as a source of water supply.	Lead administrator.
310 CMR 15.00 "Title 5"	DEP *Administered locally by board of health*	Subsurface Sewage Disposal	Regulates siting, design, and inspection of on-site systems.	Review water quality, other data to screen for sites. When potential problems arise, work with BOH to resolve.
310 CMR 10.00	DEP *Administered locally by conservation commission*	Wetlands	Restricts alteration and/or filling of wetlands; requires review of all projects within 100 feet of wetlands or within floodplains.	Work with conservation commission to see that regulations are followed by property owners.
310 CMR 13.00	DEP *Administered locally by conservation commission*	Rivers Protection Act	Establishes protected wetland resource area – riverfront.	In most cases, riverfront resource area = primary protection zone of WsPA.
40 CFR Parts 9, 122, 123 and 124	EPA *Administered by DEP*	Stormwater Phase II	Replaces/augments DEP Stormwater Management Policy; part of NPDES program.	Discussed in Section 6.2.
310 CMR 40.0000	DEP	Hazardous Waste Site Cleanup (Mass Contingency Plan)	Establishes a process for prioritization, investigation, and cleanup of hazardous materials releases.	RP submit copies of all reports to BWM for review; when necessary comments made to RP and/or DEP.
310 CMR 40.0000	DEP	Underground Storage Tanks	Regulates design and construction of new or replacement tanks.	BWM monitors information.
527 CMR 4.00 & 9.00	DFS, local fire department	Underground Storage Tanks	Removal, installation and maintenance of USTs.	BWM monitors information.

Regulation	Authority	Issue	Relevance	BWM Role[1]
304 CMR 11.00	DCR	Forest Cutting Practices Act	Regulates how forests are managed.	Discussed in Section 6.4.2.
301 CMR 11.00	EOEA	Massachusetts Environmental Policy Act (MEPA)	Requires comprehensive environmental assessment and public review of major projects.	Per MEPA regulations, BWM should receive copies of all watershed projects; BWM reviews and comments on projects. Any project requiring a WsPA Variance, except for a Single Family House, requires the filing of an ENF.
333 CMR 1.0 to 12.0	DAR	Pesticide Regulations	Restricts type and location of pesticides; requires filing of 5-year Vegetative Management Plans and annual Yearly Operating Plans.	BWM reviews VMPs and YOPs in the watershed to see that resources are correctly identified; review applications to ensure that no spray areas are observed.

Source: DCR/DWSP/BWM, 2003; DEP – see www.state.ma.us/dep/matrix.htm.

[1] BWM may have overlapping jurisdiction if parcel is subject to the Watershed Protection Act (See Section 5.2.1).

These laws and regulations act as a significant control over potentially polluting activities on private lands. This section discusses the protection afforded by this body of laws, their enforcement within the Wachusett Reservoir watershed, and BWM's role in enhancing their administration and enforcement.

Current Program and Accomplishments

The 1998 Plan called for continued MDC presence and surveillance in the watershed, and improved coordination with DEP and other agencies with regulatory responsibilities. MDC and DEP developed and signed a Standard Operating Procedures document for joint compliance and enforcement. The Bureau developed a database and tracking system for sites investigated in the watershed under 350 CMR 11.09.

In 2002, problems were reported and investigated on 80 sites. Issues investigated included problems with on-site wastewater disposal, erosion into resources from construction sites, chemical releases, illegal dumping, and flooding caused by beaver impoundments. Problems were resolved at 65 of the sites. Staff continues to monitor the other 15 sites and work with the owners and appropriate agencies to see that the issues are resolved.

Assessment

There is a strong framework of environmental laws and regulations that provides protection of the water resources in the Wachusett Reservoir watershed. Bureau staff work to coordinate these laws and regulations with BWM's own regulations.

Control Approach

Goals

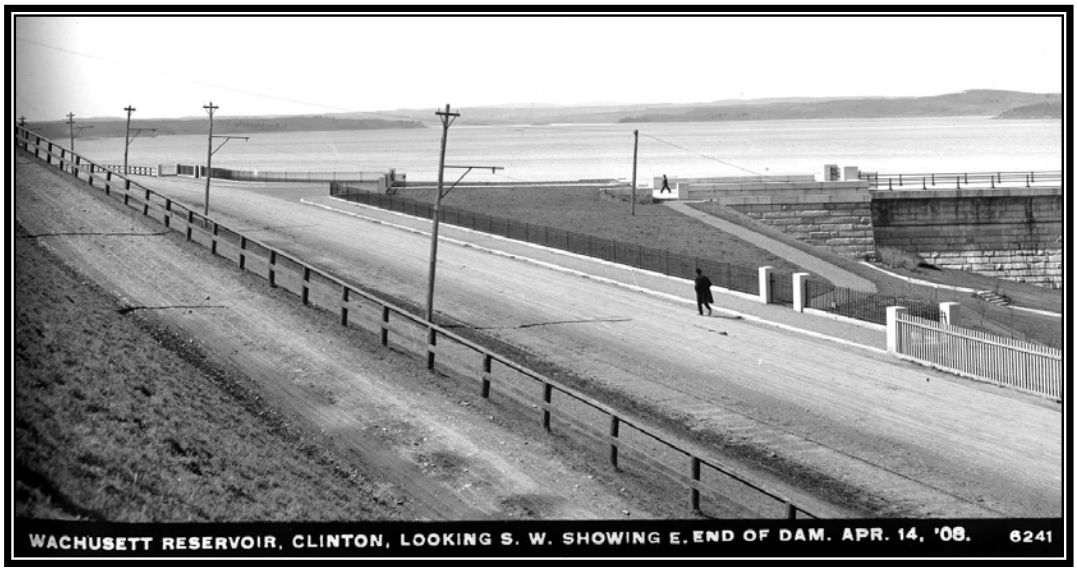
- To work cooperatively with appropriate agencies towards maximum feasible compliance with all environmental regulations.
- To be consistent in application and interpretation of regulations.

Objectives

- Work with appropriate authority to ensure that all environmental regulations are followed.
- Integrate all relevant BWM regulations with appropriate environmental regulations administered by other federal, state and local authorities.
- Monitor compliance with all environmental regulations through water quality testing, EQAs, and general watershed surveillance

Action Items

- Continue to meet, as necessary, with DEP, DAR and other agencies to enforce compliance with existing environmental regulations.
- Review DEP Enforcement protocol.
- Continue to monitor cases through EQ and WsPA tracking system.
- Continue to screen for potential violations through ongoing water quality monitoring, environmental quality assessments, and field surveillance.



5.3 Environmental Quality Assessments

Accomplishments:
- Replaced historic general inventory of threats with detailed subbasin-level, Environmental Quality Assessments (EQAs). Published two assessments, Reservoir and Thomas Basin Districts, and a third, Quinapoxet, will be completed by the end of 2003.
- Compiled all recommendations from Reservoir and Thomas Basin Districts EQAs and initiated implementation recommendations.
- Implemented use of updated databases to track ongoing activity in the watershed
- Initiated in-depth studies on four subbasins with historically elevated fecal coliform bacteria concentrations.

Assessment:
The details provided by the Bureau's EQAs help identify water quality problems, link those problems to the sources of contamination, and develop specific, prioritized goals for corrective actions. EQAs provide a tool to track the impacts of septic systems on a sub-watershed basis.

Key Actions:
- Maintain five-year cycle/rotation for completion of Environmental Quality Assessments based upon the following order.
  1. Publish Quinapoxet EQA.
  2. Complete Stillwater EQA
  3. Complete Worcester EQA.
  4. Update Reservoir EQA.
  5. Update Thomas Basin EQA.
- Continue to conduct in-depth studies on subbasins with complex water quality problems.
- Produce annual status report on all recommendations in past EQAs.

Background

BWM established an ongoing sanitary survey program within the watershed in 1988 to address existing and potential threats to water quality, and to ascertain compliance with state regulations. The Wachusett Reservoir watershed was subdivided into sanitary districts for the purpose of scheduling the completion of sanitary surveys on a rotating three-year basis, and three reports were completed in the early 1990s.

Current Program and Accomplishments

The Wachusett Reservoir watershed was realigned in 1998 into five sanitary districts: Reservoir, Thomas Basin, Quinapoxet, Stillwater, and Worcester. Reports are now generated annually on a five-year rotating basis with a goal of completing one district per year. It was recognized that previous sanitary surveys, while useful, were fairly general both in their inventory of resources and in their identification of specific threats and corrective measures. In order to improve the effectiveness of watershed protection efforts, it was decided to refine the process and complete a much more detailed inventory and assessment of each district at the subbasin level. A total of 49 subbasins were identified within the five Wachusett Reservoir districts, many with years of tributary-specific water quality data. The DEP requires an annual sanitary survey of the entire watershed; to

avoid confusion, it was decided to refer to each of these reports as District Environmental Quality Assessments (EQA). The Reservoir and Thomas Basin EQAs have been published and the Quinapoxet EQA will be completed by the end of 2003.

Completion of an environmental quality assessment is only the first step. Once specific threats have been identified and recommendations for remediation developed, it is necessary for action to take place. A detailed list of all recommendations from the first two EQAs has been produced and priorities established; work is underway on many of these recommendations and a number have been completed. These recommendations include additional water quality sampling in problem subbasins, modification of BWM maps to reflect field verified hydrology, stormwater improvements on state highways and BWM properties, continued cooperation with local boards of health to remediate inadequate septic systems, and additional inspections of agricultural, commercial, and industrial sites. Many of these recommendations are described in relevant sections of this update.

Water quality from Beaman Pond Brook has historically been among the worst in the Wachusett Reservoir watershed. A focused sampling program was initiated following completion of the Reservoir EQA, combining a new understanding of potential threats and updated hydrology. Similar investigations have begun in the Boylston Brook, Oakdale Brook, and Malagasco Brook subbasins.

A database of all incident responses and field investigations now exists and is kept current. Each file is associated with a specific subbasin. Minutes from local boards of health, conservation commissions, and planning boards are obtained each month and relevant information on new growth or septic system problems is documented. BWM has obtained digital copies of town board of health records where available and is able to update these using board of health minutes, which in turn enables the Bureau to locate problem areas and helps focus remediation efforts. Summary water quality data are maintained in a single spreadsheet to help track trends and identify problems.

Assessment

The detailed Environmental Quality Assessment subbasin approach was adopted by BWM to more easily identify and relate observed water quality problems with sources of contamination in the tributaries of the Wachusett Reservoir. These assessments provide a thorough analysis of the health of each individual subbasin, allowing BWM to define specific goals for maintaining and improving water quality in each basin area.

The goals of this program are currently being met. A focused identification of threats and prioritized listing of corrective actions has led to more effective follow-through and resolution of significant problems in the watershed.

Control Approach

Goals

- To provide a comprehensive inventory of resources as well as an overview of existing and potential threats to the water supply.
- To provide a framework for prioritization of remediation and protection activities within the watershed.

Objectives

- Complete detailed assessments of subbasins on a five-year cycle in order to identify potential water quality problems, seek out sources of the problems, and identify options for remediation.
- Utilize the greater level of detail provided by EQA, which replaces the more generalized watershed-wide approach, for a more focused approach to threat identification.

Action Items

- Maintain five-year cycle/rotation for completion of Environmental Quality Assessments based upon the following order:
  1. Publish Quinapoxet EQA.
  2. Complete Stillwater EQA
  3. Complete Worcester EQA.
  4. Update Reservoir EQA.
  5. Update Thomas Basin EQA.
- Implement recommendations for completed EQAs.
- Produce annual status report on all recommendations in past EQAs.